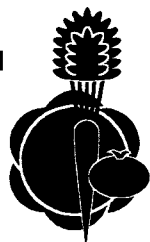


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# ASPARAGUS PRODUCTION IN CALIFORNIA

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## PRODUCTION AREAS AND SEASONS

California has three primary asparagus (*Asparagus officinalis* L.) production areas: the southern desert valleys (Imperial and Riverside Counties), the Sacramento–San Joaquin River Delta (San Joaquin County), and the Central Coast (Monterey and Santa Barbara Counties). Limited production is also found in Kings, Orange, Contra Costa, Yolo, Ventura, and Sacramento Counties. Asparagus is a perennial crop that is normally harvested once a year over an 8- to 10-week period. In the southern desert valleys, asparagus may be harvested either from December to early April (main season) or in October if the market is favorable. In the Delta, asparagus is harvested from late February through May. In the Central Coast, harvest is from March to mid-June; in the southern Central Coast, there is a summer harvest from mid-July through September.

All California-grown asparagus is green for fresh market with a very small amount of production for processing. Due to high labor requirements, white asparagus, which is grown in the absence of light, is more expensive to produce in California compared with countries that have cheaper labor costs.

## ASPARAGUS ACREAGE AND VALUE

Year	Acreage	Average yield (tons/acre)	Gross value/acre
1995	28,000	1.40	\$3,267
1994	30,200	1.65	\$3,367
1993	32,100	1.45	\$2,747

Source: *California Agricultural Statistics 1995* (Sacramento: California Department of Food and Agriculture, 1996).

## CLIMATIC REQUIREMENTS

Asparagus favors temperate climates. Optimum root and fern growth occurs between 65° and 85°F (18° and 29°C). Spear initiation occurs at soil temperatures above 50°F (10°C); spear elongation is faster at higher air temperatures. Root and fern development are reduced at temperatures below 55°F (13°C) or above 85°F (29°C). Warm weather causes the spear tips to open (feather) prematurely, reducing overall spear quality.

For early production, fields are located in warm locations, especially in the desert valleys. The sites may be in the irrigated areas along the edges of native desert or near a large body of water that moderates temperatures. Fields with sandy soils tend to be warmer than those with silty clay or clay soils.

## VARIETIES AND PLANTING TECHNIQUES

**Varieties.** The main varieties grown in the desert valleys are UC157 F<sub>1</sub>, Brock Imperial, Grande, Apollo Atlas, and Ida Lea. The principal cultivar grown in the Delta and the Central Coast is UC157, with limited acreages of Apollo, Atlas, and Purple Passion (a specialty line).

**Planting.** Asparagus may be established by three methods: transplanting of 10- to 12-week-old greenhouse seedlings, planting of field-grown one-year-old crowns, or direct seeding. October through March is usually best for establishing asparagus stands with transplants or crowns. In the southern deserts, a limited harvest may be feasible within 14 months from a November transplanting. Planting one-year-old crowns in late winter or early spring will produce yields of 500 to 1,000 pounds per acre (560–1,120 kg/ha) of asparagus the following year.

Fall plantings from seed may be made in August or September. In the low desert, asparagus seed is often spring planted from February to April, taking nearly 2 years to yield substantial production. Seed are often planted in two rows 8 to 12 inches (20–30 cm) apart, and the seed is placed 0.75 to 1 inch (1.9–2.5 cm) deep with an in-row spacing of 3 to 6 inches (7.5–15 cm).

Seedling transplants or one-year-old crowns are normally placed in the bottom of a furrow and soil is mounded over the plants as they develop to fill in and form a raised bed. Bed width varies from 40 to 72 inches (100–180 cm), depending on grower preference. In-row spacing for seedling transplants and crowns is usually 6 to 12 inches (15–30 cm). In the desert, there are normally two rows per 60-inch (1.5-m) bed, giving a population of 17,000 to 20,000 plants per acre (42,500–50,000 plants/ha). Planting of one-year-old crowns is still the primary method of crop establish-

ment in the Delta and the Central Coast; plant populations utilizing one row per bed vary from 9,000 to 13,000 plants per acre (22,500–32,500 plants/ha).

### **SOILS**

Careful attention should be given to field selection because asparagus will occupy the land for 8 to 10 years. Fields should be uniform in soil type to facilitate timing of irrigation that is appropriate for the whole field. Locations known to have problems with bermudagrass (*Cynodon dactylon* L.), field bindweed (*Convolvulus arvensis* L.), johnsongrass (*Sorghum halepense* L.), or nutsedge (*Cyperus* spp.) are poor choices for asparagus production because these perennial weeds are difficult to control in established asparagus. The ideal pH for asparagus is 6.5 to 7.5. Acidic conditions (less than pH 6.5) can lead to reduced growth and yield. Corrective annual applications of lime may be necessary to elevate pH levels.

In the principal asparagus production area of California, the Sacramento–San Joaquin River Delta, most of the soils are high in organic matter with a high water table. Care must be exercised in applying water to these soils to prevent development of soilborne diseases. Provisions are made for drains and pumps to remove water from irrigation and rainfall. A wide variety of sedimentary soils (ranging from sandy loam to some clay loams) are used for asparagus production in areas adjacent to the San Joaquin Delta and along the Central Coast. Shallow soils or those with a perched water table should be avoided as these conditions lead to a short stand life due to unhealthy or diseased roots. In the low desert valleys, well-drained sandy loams and loams are best for asparagus production.

### **IRRIGATION**

Fifteen or more furrow irrigations per year are required for asparagus grown in the low desert valleys. The interval between irrigations during the summer is from 10 to 15 days. During harvest, a 30- to 60-day period, irrigations are made to alternate furrows to allow for a dry furrow for foot traffic. Harvest crews are encouraged to walk in dry furrows rather than on bed tops where they might damage emerging spears. Mechanical damage causes distortion or breakage as the spears elongate, making them unmarketable.

In the San Joaquin Delta, many of the fields high in organic matter are flooded for a period of 30 days during the winter, when the crop is dormant, to refill the soil profile and leach salt accumulation. Other production fields on sedimentary soils in the Delta and along the Central Coast rely on winter rainfall for early-season moisture. Generally, no irrigation or alternate-furrow irrigation is practiced during the harvest season in these production areas. At the end of harvest, if furrow

irrigation is practiced, two or three well-spaced irrigations are applied during the summer and fall or overhead sprinkler irrigation is utilized as needed.

The use of drip irrigation in asparagus is increasing. The typical drip irrigation system in use employs drip tape or tubing 12 to 16 inches (30–40 cm) deep with one line per bed. Irrigation needs for drip irrigation are determined by weather-based reference evapotranspiration ( $ET_0$ ) estimates and crop growth stage; frequency of irrigation can vary from once or twice a week early in the season to daily during periods of peak water demand.

### **FERTILIZATION**

Fertilization practices in asparagus production vary greatly. Requirements depend on the soil type, crop location, crop age, irrigation method, and climatic conditions. When preparing a field for an asparagus planting, a general recommendation is to apply 100 pounds per acre (112 kg/ha) of nitrogen (N), 50 pounds per acre (56 kg/ha) of phosphorus (P), and 100 pounds per acre (112 kg/ha) of potassium (K). An established asparagus field might require 100 to 400 pounds per acre (112–448 kg/ha) of nitrogen (the higher rates are particularly applicable to the sandy soils in the low desert) and 100 to 200 pounds per acre (112–224 kg/ha) of phosphate ( $P_2O_5$ ) per year. All of the phosphate and about half of the nitrogen is applied before the cutting season. The remaining nitrogen is applied during and/or after the harvest season before fern development. Most California asparagus soils do not need applications of potassium; if needed, an application of 100 pounds per acre (112 kg/ha) of  $K_2O$  would be used.

### **INTEGRATED PEST MANAGEMENT**

Detailed information about IPM for asparagus is available by contacting the UC IPM World Wide Web site at <http://www.ipm.ucdavis.edu> (see *UC IPM Pest Management Guidelines*, DANR Communication Services Publication 3339). Herbicides, insecticides, fungicides, and preplant fumigants should always be used in compliance with label instructions.

**Weed management.** Weeds can become a serious and costly problem in both newly planted and established asparagus. Selection of a relatively weed-free planting site is essential. Prior to planting, the use of irrigation to germinate weeds followed by cultivation and/or the use of a postemergence herbicide can aid in reducing weed competition. On established asparagus, a pre-emergence herbicide should be applied after the fern is chopped and burned but before the start of the harvest season. Water in the form of rainfall or sprinkler irrigation is needed to activate the herbicide. During the cutting season, spot treatments with a herbicide may be necessary. Herbicide application after the

cutting season (but before fern regrowth) is practiced where sprinkler irrigation is used.

**Insect identification and control.** Western yellow-striped armyworm (*Spodoptera praefica*), beet armyworm (*Spodoptera exigua*), bean thrips (*Caliothrips fasciatus*), flower and onion thrips (*Frankliniella* spp.), and asparagus beetle (*Crioceris asparagi*) have been traditional pests requiring limited insecticide treatments. If found in maturing ferns, the European asparagus aphid (*Brachycorynella asparagi*) is the most serious pest requiring more extensive insecticide treatments for control. Asparagus miner (*Ophiomyia simplex* Loew) may need to be controlled periodically. Garden symphylan (*Scutigera immaculata*), a white arthropod closely related to an insect, may cause damage to asparagus roots and crowns, leading to some crop stand loss if found in large numbers. Preplant and post-cutting application of a soil-active insecticide is essential to control this pest.

**Disease identification and management.** Fusarium wilt (*Fusarium oxysporum*, f.sp. *asparagi* and *F. moniliforme*) is the most serious disease affecting asparagus production worldwide. It causes a slow decay of the crown and reduction in spear size and number, ultimately leading to lower yields. The problem increases with the age of the crop stand. Severity of the disease can be reduced with the selection of vigorous-growing varieties (hybrids), use of clean seed and one-year-old crowns grown in non-infested soil, and good irrigation management. Replanting asparagus in the same area should be avoided for at least a 10-year period. Fusarium wilt has a drastic effect on younger asparagus plantings in infested soil. Excessive harvesting of mature asparagus weakens the crowns and increases stand decline caused by *Fusarium* species.

Asparagus crown and spear rot (*Phytophthora megasperma* var. *sojæ*) is a soilborne fungal disease that is a problem particularly in soils that are saturated due to poor drainage, heavy rainfall, or excessive irrigation. Crown rot and spear slime can occur if corrective and preventive measures are not employed, resulting in stand loss and reduced production. Chemical and cultural controls can be employed against this disease.

Asparagus rust (*Puccinia asparagi*) and Cercospora stem and leafspot (*Cercospora asparagi*) are two fungal diseases affecting the asparagus fern. They may require chemical control during some years. Good irrigation management, wide row spacings, and orientation of planted rows with the prevailing wind may help reduce incidence of asparagus rust.

Asparagus purple spot (*Stemphylium vesicarium*) may occur during cool, wet weather at harvest. It causes oval-shaped purple spots on the spears. The spots elongate and produce grayish white, slightly sunken centers within the lesion. The primary source of inoculum for purple spot is fern debris from the previous season's

crop. Good sanitation, including fern chopping, burning, and soil incorporation of the remaining debris, minimizes occurrence of the disease under California's climatic conditions.

Asparagus viruses I and II (AVI and AVII) are symptomless, latent diseases that can result in decreased production and reduced plant vigor over time, particularly when both viruses are present in a field. AVI is insectborne and moves through a field as insects move pollen from an infected male plant to female plants. AVII is the more serious of the two viruses because it is seedborne and has been spread to some degree into most asparagus production areas in California. The best control measure is to plant fields with certified virus-free seed or transplants cloned from healthy mother plants. AVII is also spread via sap transmission on cutting knives during harvest. Recently, AVII has been shown to predispose plants to further damage from *Fusarium* and probably *Phytophthora* as well.

### **HARVESTING AND HANDLING**

Mature ferns are either chopped, often as part of the green trash hauled from the field, or windrowed with a swather. After drying, chopped ferns may be burned and/or incorporated into the bed with a rotary power tiller. Fern chopping occurs from late November to early December in the desert and Delta growing areas. Following chopping, the planted beds are reworked to loosen the surface soil, reshaped, and fertilized. In the desert valleys, asparagus is irrigated prior to the first harvest, which usually takes place in mid-December. The same procedure is followed in the Delta and the Central Coast, but the fields there are also either winter-flooded or rely on winter rainfall to fill the soil profile.

Emerging spears are hand-cut. Early in the season, fields are harvested every 2 or 3 days, but during warm weather fields are cut daily. Spears are cut at an angle just below the soil surface with an asparagus knife. Spindly or otherwise deformed spears are cut and discarded to allow for growth of marketable spears. Cut spears must be approximately 10 inches (25 cm) long to allow for a trim to 9 inches (22.5 cm) during packing. Harvested spears are placed on the beds in bunches, gathered, and placed in field boxes or cart-carrying tractors. Then they are taken out of the field and hauled to sheds for grading, packing, trimming, and cooling.

Defects and loss of production at harvest can occur for various reasons. Prolonged wind causes spears to curve. Spears can grow at a rate of 3 to 6 inches (7.5–15 cm) per day depending on temperature. Windborne soil debris may pit the emerging spears, making them unmarketable. Trampling or inadvertent cutting of emergent spears and high temperatures cause misshapen spears. Cutting spears too far below the ground

may cause the additional loss of spears that never reach the bed surface. High temperatures cause flowering or premature break of the bracts, especially in small spears. This condition is commonly referred to as “feathering” because of the featherlike appearance of flowering spears. Harvesting a bed for too long during the season may also cause spear feathering due to low carbohydrate levels in the crowns. Flattened or effaced spears (“flats”) are the result of certain varietal characteristics. Thrips and mite feeding can cause significant reduction in the cosmetic appeal of spears.

Freezing temperatures during spear emergence can cause “frosting,” discoloration of green spears. Frosted spears may still be marketable, albeit at a reduced value, but most often they are discarded. If spears are cut while frozen, damage is usually severe and the product is not marketable. Sometimes ice formation is difficult to see because the ice is clear, a condition known as “black ice.” A field with black ice will appear to be a darker green than normal.

Excess harvesting leads to a decline in production and a proliferation of small spears. A full cutting season (60–75 days) may begin the fourth year after planting. Fields in their second year of production after transplanting (crowns or seedlings) may be harvested yielding 25 to 50 30 lb-cartons per acre, but the harvesting period should be limited to 3 to 4 weeks and should only be done in the most vigorous plantings. During the third year, 50 to 80 cartons per acre may be harvested. Depending on location, field history, irrigation, fertilization, length of cutting season, etc., the subsequent full harvest seasons can result in yields of 133 to 200 cartons (4,000–6,000 lb/acre).

Asparagus fields should produce good yields for 8 to 10 years. Asparagus is capable of a much longer production life, but it is usually limited in later years by weed infestations, disease infections, and overcutting of the beds.

#### **POSTHARVEST HANDLING**

Asparagus is packed in various sizes of containers (wood and fiberboard) including 30-pound loose, 28 bunches per crate (net weight 28 lb), and 11 bunches per crate (net weight 11 lb). Spear sizes for these packs are Extra Large ( $^{10}/_{16}$ -inch diameter), Large ( $^{7}/_{16}$  in),

Standard ( $^{5}/_{16}$  in), and Small ( $^{3}/_{16}$  in). Diameter is measured at the widest point of the spear. Another commonly used container holds six 2.25-pound bunches (net weight 13.5 lb) often used for international shipment. Sizes for this pack include Colossal (no more than 14 spears per bunch), Jumbo (15–20 spears), Extra Large (18–24 spears), Large (21–28 spears), and Standard (29–42 spears).

Some of the product is packed in 30-pound wooden crates, chiefly for Japanese export. There are also 27-pound cartons (twelve 2.25-lb bunches) for domestic and export markets, 18-pound cartons of asparagus tips (5.5–7 inches in length) for domestic use, and 15-pound cartons packed loose for export, primarily to Europe.

Asparagus is an extremely perishable product that must be cooled quickly after harvest. Local packing sheds hydrocool spears to remove the field heat after packing. Chlorinated water at approximately 34° to 37°F (1.1° to 2.8°C) is drenched over the packed cartons for approximately 15 minutes to remove the field heat from the spears. To maximize shelf life, asparagus should be stored at 36° to 40°F (2.2° to 4.4° C) with 90 to 95% relative humidity.

At high temperatures, asparagus spears lose natural sugar, flavor, and vitamin C, and they become tough and start to decay. If rapidly cooled and held at 36°F (2.2°C), asparagus may be kept for about 3 weeks. Desiccation can occur rapidly if the butt ends of the asparagus spears are not placed on wet pads since spears continue to elongate after harvest. Storing asparagus in unventilated containers results in spear toughening. Bacterial soft rot occurs at either the spear tips or butts if they are not quickly brought to optimum storage temperature and humidity.

#### **MARKETING**

California is the leading asparagus producing state in the United States, followed by Washington, Michigan, New Jersey, and Illinois. California produces asparagus for 9 months of the year with the heaviest production in February to June. About 30 percent of California asparagus production is exported, primarily to Japan, Europe, and Canada.

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